

Observed HR diagrams and stellar evolution: the interplay between observational constraints and theory
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Wide Field H-R diagrams of Local Group Dwarf Galaxies

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Abstract. We present new observations of Sextans and Leo I dwarf galaxies, that provide new insight on their stellar populations. The large sample of stars measured in Sextans allowed us to obtain a reliable estimate of the metal content of this galaxy, to study the population spatial gradients, and to investigate the nature of the large number of blue stragglers. In Leo I, we discovered a significant population of RR Lyrae variables. The analysis of the pulsational properties of the detected variables suggests that this galaxy is an Oosterhoff intermediate object, similar to the LMC and to other dwarf galaxies in the Local Group.

1. Introduction

The work presented here is part of an ongoing project to determine the star formation and chemical enrichment history of Local Group dwarf galaxies. By means of CCD observations obtained with the WFI camera at the MPG/ESO 2.2m telescope at La Silla, Chile, the different stellar populations in the dwarf spheroidal (dSph) galaxies Sextans, Sculptor, Leo I, Carina, Fornax and in the dwarf irregular NGC 6822 have been studied. Here we highlight the main results obtained for the Sextans and Leo I dwarf spheroidals.

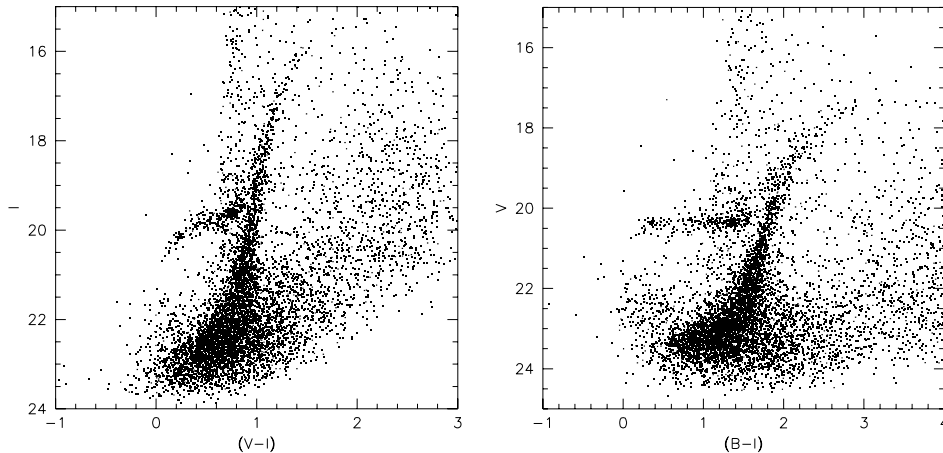


Figure 1. The $(V-I)$, I and $(B-I)$, V colour magnitude diagrams of the Sextans dwarf spheroidal

2. Stellar Populations in the Sextans dwarf spheroidal

Discovered by Irwin et al. (1990), the Sextans dSph galaxy is a perfect target for wide field observation, because of its low stellar density and large extent (see Irwin & Hatzidimitriou 1995). Colour-magnitude diagrams of the galaxy were presented by Mateo et al. (1991) and by Mateo, Fischer, & Kremski (1995), the latter in a search for RR Lyrae variables. Their diagrams showed, in addition to a predominantly old population, a large number of stars brighter than the main sequence turn off of a ~ 10 Gyr old population, tentatively identified as a minor intermediate age component. Both studies resulted in a metallicity determination around $[\text{Fe}/\text{H}] = -1.6$. Photometry in the Washington system was obtained by Geisler & Sarajedini (1996), yielding a metallicity of $[\text{Fe}/\text{H}] = -2.0$. A wide field colour-magnitude diagram was presented by Pancino, Bellazzini, & Ferraro (this conference), suggesting the possible presence of a double population of stars at metallicities of $[\text{Fe}/\text{H}] \sim -2.5$ and $[\text{Fe}/\text{H}] \sim -1.8$. Spectroscopy of red giants was obtained by Suntzeff et al. (1993) and by Shetrone, Côté, & Sargent (2000). Using the Ca II infrared triplet, both studies resulted in a value of about $[\text{Fe}/\text{H}] = -2.0$, with an intrinsic abundance spread of 0.2 dex.

Two questions were left open by previous studies: the first is the determination of the metal content of this galaxy; the second is the nature of the stars brighter than the main sequence turn off. The observations presented here (Fig.1) cover the widest area ever observed (~ 0.5 square degrees) and reach down to magnitude $V=24$ (50% completeness level).

2.1. The metal content of Sextans

These data allowed us to measure Sextans metallicity from the comparison of the observed RGB with fiducial ridge lines of Galactic globular clusters. Using the method suggested by Saviane et al. (2000), based on iterative and simultaneous fitting of distance, metallicity, and reddening, a value of $[\text{Fe}/\text{H}] = -1.91 \pm 0.16$ was derived. The intrinsic width of the RGB implies a metallicity dispersion of

0.2 dex. Both values are in agreement with previous spectroscopic determination obtained with the Ca II infrared triplet.

2.2. The nature of the “blue-stragglers”

Mateo et al. (1995) suggested that the large number of stars brighter than the main sequence turn off may be explained by the presence of a minor intermediate age population. Alternatively, these could be old stars like those found in Galactic globular clusters, in which case we expect them to be centrally concentrated. To discriminate between these two hypotheses, we analyzed the spatial distribution of these stars. No evidence of central concentration could be found. Further, the intermediate age case was tested by means of simulated diagrams obtained using the ZVAR code (G. Bertelli 1997, unpublished).

Our conclusion is that these stars most likely represent a secondary star formation episode, since (a) the number of stars brighter than the main sequence turn off is larger than in most globular clusters, and (b) there are no signs of central concentration of these stars. Indeed, Sextans is a very low concentration system that is unlikely to form a large number of blue stragglers. According to our analysis, Sextans started forming stars at an early epoch ($\sim 13 \div 15$ Gyr ago) and formed most of its stars in this first episode. A second episode of star formation happened about 5 Gyr ago, in which up to 5 % of the mass in stars was formed.

3. Tracing the old population in Leo I: the RR Lyrae variables

With its predominantly young and intermediate age population and seeming lack of an old component, Leo I was long thought to be an exception in the general picture of the Local Group dwarfs.

However, an old population has been revealed by a horizontal branch extended from blue to red (Held et al. 2000). Given the presence of this extended HB and the low metallicity of the system ($[\text{Fe}/\text{H}] \sim -2$, Lee et al. 1993), one would naturally expect to find RR Lyrae. Indeed, a significant population of RR Lyrae variables was discovered using a time series of 62 WFI camera images of the galaxy (Held et al. 2001). Full coverage of the light variations and pulsation periods have been obtained for 54 of the 74 candidates we found. 47 of them are Bailey *ab*-type RR Lyrae and 7 are *c*-type. Figure 2 shows the location of the detected variable stars in the colour-magnitude diagram of Leo I from the data of CCD No. 6. The average period of the Leo I RRab variables is $\langle P_{ab} \rangle = 0^{\text{d}}60$, and the minimum period is $0^{\text{d}}54$. The pulsational properties of the RR Lyrae’s qualify Leo I as a system intermediate between Oosterhoff I and Oosterhoff II clusters, similar in this respect to other dwarf galaxies in the Local Group and to the LMC. Using Sandage (1993) formula, the average period of the *ab*-type RR Lyrae’s provides an independent estimate of the metallicity for the old population: $[\text{Fe}/\text{H}] = -1.82$, although a significant spread in metallicity seems to be present. From the mean magnitude of the RR Lyrae’s a distance modulus of $(m - M)_0 = 22.04 \pm 0.12$ has been estimated using the metallicity value derived in this work. These results are in excellent agreement with our recent metallicity and distance determinations on a different data set (Momany et al. 2001, in preparation).

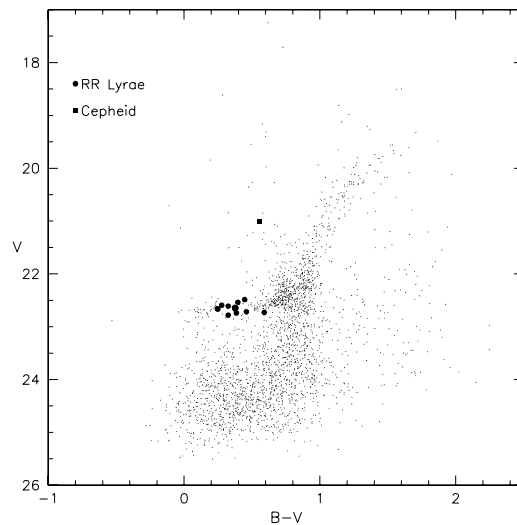


Figure 2. CM diagram of Leo I from CCD No. 6 covering the outer region of the galaxy. Filled circles represent the variable stars which has been plotted according to their average magnitudes and colors. The brighter point is an anomalous Cepheid.

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